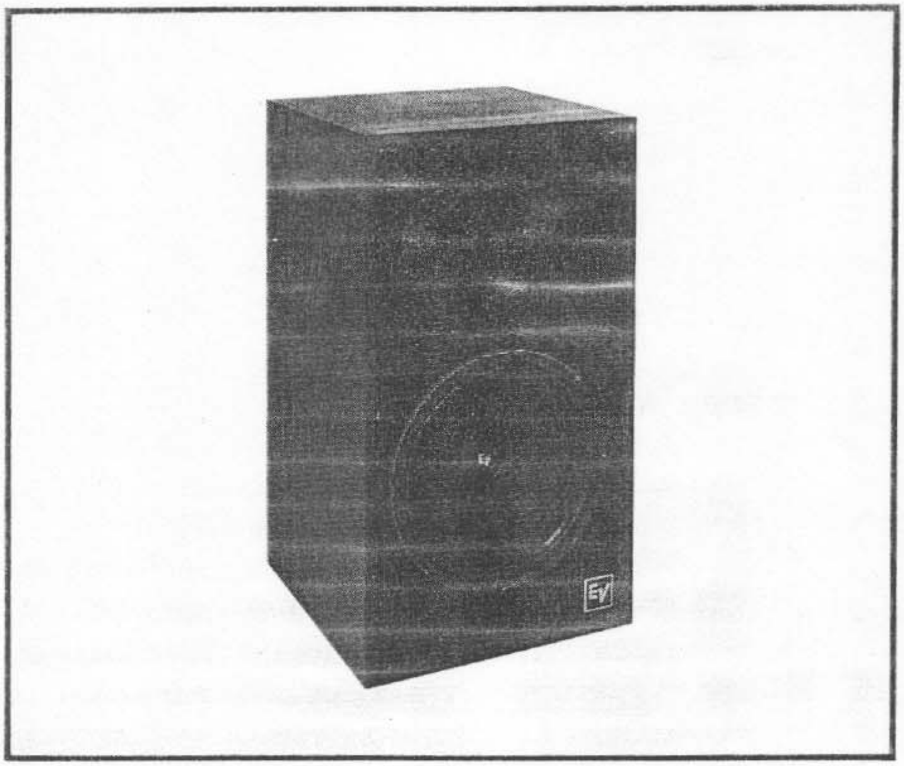


Electro-Voice®

a gulton company

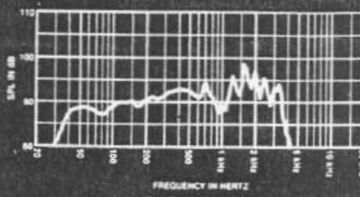


FIGURE 1
Axial Frequency Response
4 Volts/10 Feet

Model TL3512
Very-Low-Frequency Speaker System

SPECIFICATIONS:

Frequency Response, 10 Feet on Axis, Swept One-Third-Octave Pink Noise, Half-Space Anechoic Environment (see Figure 1):
38-3200 Hz

Low-Frequency 3-dB-Down Point,
Normal:
38 Hz
Step-Down (with equalization):
28 Hz

Usable Low-Frequency Limit (10-dB-down point),
Normal:
28 Hz
Step-Down (with equalization):
24 Hz

Half-Space Reference Efficiency:
2.9%

Long-Term Average Power Handling Capacity per EIA Standard RS-426A (see Power Handling Capacity section):
400 watts

Maximum Long-Term Average Midband Acoustic Output:
11.6 watts

Sound Pressure Level at 1 Meter, 1 Watt Input, Anechoic Environment, Band-Limited Pink-Noise Signal,
100-800 Hz:
99 dB
36-125 Hz:
95 dB

Dispersion Angle Included by 6-dB-Down Points on Polar Responses, Indicated One-Third Octave Bands of Pink Noise,
36-125 Hz Horizontal and Vertical (see Figure 3):
360°
400-800 Hz Horizontal (see Figure 3):
105° ± 5°
400-800 Hz Vertical (see Figure 3):
110° ± 5°

Directivity Factor R_θ (Q), Median over Indicated Range,
38-125 Hz (see Figure 4):
1.0
400-800 Hz (see Figure 4):
5.7

Directivity Index D_i, Median over Indicated Range,
38-125 Hz (see Figure 4):
0.0 dB
400-800 Hz (see Figure 4):
7.5 dB

Distortion, 0.1 Full Power Input (see Figure 5),
Second Harmonic,
100 Hz:
1.4%
1000 Hz:
2.4%
Third Harmonic,
100 Hz:
0.4%
1000 Hz:
1.7%

Distortion, 0.01 Full Power Input (see Figure 6)
Second Harmonic,
100 Hz:
0.4%
1000 Hz:
0.7%
Third Harmonic,
100 Hz:
0.4%
1000 Hz:
1.2%

Transducer Complement:
(1) DL18W

Box Tuning Frequency,
Normal:
35 Hz
Step-Down:
25 Hz

Impedance,
Nominal:
8 ohms
Minimum:
8 ohms

Input Connections:
Screw Terminals (#8-32) on barrier strip

Enclosure Materials and Finish:
Black vinyl clad particle board

Mounting:
Hanging via six ¼-20 T-nuts

Dimensions,
Height:
100.3 cm (39.5")
Width:
57.2 cm (22.5")
Depth:
55.9 cm (22.0")

Net Weight:
49.0 kg (108 lb)

Shipping Weight:
54.4 kg (120 lb)

DESCRIPTION

The Electro-Voice TL3512 is an optimally vented, direct-radiator speaker system for high-output reproduction of very-low frequencies. The low-frequency limit of 38 Hz (3 dB down) may be extended to 28 Hz by covering one vent and applying appropriate low-frequency equalization (see Step Down section). The TL3512's design is based on the vented-enclosure modeling technique of A.N. Thiele and R.H. Small, which makes possible a combination of high efficiency, low distortion and extended low-frequency performance in an enclosure of moderate size.

The TL3512 employs a DL18W very-low-frequency reproducer in a 9-cubic-foot (255 liter) enclosure. The DL18W's high linear cone-excursion ability (X_{max} = 0.22 inches, zero to peak) and 400-watt long-term average power capacity contribute substantially to the TL3512's high acoustic output ability (see Power Handling Capacity section). The enclosure is equipped with a sturdy metal grille screen and is constructed of black, vinyl-clad particle board of ¾-inch thickness, internally braced.

APPLICATIONS

The TL3512 is ideal for a wide variety of high-output subwoofer applications, in permanently installed sound reinforcement and music playback systems. Typical venues include cinemas, auditoriums, theaters, performing arts centers, night clubs and concert halls. Normally, the TL3512 would be used in the subwoofer frequency range, below, say, 125 Hz. However, it's frequency response and dispersion make single units appropriate for crossover frequencies as high as about 800 Hz. This means that the TL3512 can also be used as a system's primary low-frequency reproducer.

The Electro-Voice XEQ-2 active crossover/equalizer is a useful companion to the TL3512. The XEQ-2 provides appropriate crossover frequencies by plug-in module (modules other than the supplied X500 and X800 must be purchased separately; an X125 module is available). The XEQ-2 also provides equalization for step-down operation and protection from subpassband input signals (see Step Down and Subpassband Speaker Protection sections).

FREQUENCY RESPONSE

TL3512 frequency response was measured in an anechoic environment at 10 feet on axis with swept one-third octave pink noise. (See Figure 1.)

DIRECTIVITY

TL3512 directional characteristics were measured by running a set of polar-response curves in EV's large anechoic chamber. The test signal was one-third octave pseudo-random pink noise centered at the frequencies indicated in Figures 3 and 4. The curves show horizontal (side-to-side) dispersion when the enclosure's long axis is vertical. The vertical (up-and-down) polar responses are also shown.

Additional typical information is provided in Figure 3 which shows 6-dB-down beamwidth versus frequency. Figure 4 shows the directivity factor and directivity index versus frequency.

DISTORTION

Following AES (Audio Engineering Society) recommended practice, plots of second- and third-order harmonic distortion for 0.1 rated input power are shown in Figure 5. Figure 6 shows distortion at 0.01 rated input power.

POWER HANDLING CAPACITY

To our knowledge, Electro-Voice was the first U.S. manfacturer to develop and publish a power test closely related to real-life conditions. First, we use a random noise input signal because it contains many frequencies simultaneously, just like real voice or instrument program. Second, our signal contains more energy at extremely high and low frequencies than typical actual program, adding an extra measure of reliability. Third, the test signal includes not only the overall "long-term average" or "continuous" level — which our ears interpret as loudness — but also short-duration peaks which are many times higher than the average, just like actual program. The long-term average level stresses the speaker thermally (heat). The instantaneous peaks test mechanical reliability (cone and diaphragm excursion). Note that the sine-wave test signals sometimes used have a much less demanding peak value relative to their average level. In actual use, long-term average levels exist from several seconds on up, but we apply the long-term average to several hours, adding another extra measure of reliability.

Specifically, the TL3512 is designed to withstand the power test described in EIA Standard RS-426A. The EIA test spectrum is applied for eight hours. To obtain the spectrum, the output of a white noise generator (white noise is a particular type of random noise with equal energy per bandwidth in Hz) is fed to a shaping filter with 6-dB-per-octave slopes below 40 Hz and above 318 Hz. When measured with the usual constant-percentage analyzer (one-third-octave), this shaping filter produces a spectrum whose 3-dB-down points are at 100 Hz and 1,200 Hz with a 3-dB-per-octave slope above 1,200 Hz. This shaped signal is sent to the power amplifier with the continuous power set at 400 watts into the 6.9 ohms EIA equivalent impedance for the TL3512 (52.5 volts true RMS).

Amplifier clipping sets instantaneous peaks at 6 dB above the continuous power, or 1,600 watts peak (105 volts peak). This procedure provides a rigorous test of both thermal and mechanical failure modes.

STEP DOWN

Step down is a good way to extend system low-frequency response by increasing amplifier power at low frequencies instead of enclosure size. In step down, the enclosure is tuned to a lower-than-normal frequency. This increases system output at the new tuning frequency and reduces output slightly in the region of original tuning. The smoothly falling frequency response which results can be equalized to provide a new system 3-dB-down point (f_3) about 0.7 that of the original. To achieve a similar response extension without equalization would require an enclosure at least twice the size, not practical in certain installations.

To step down the TL3512, install the supplied port cover using the screws and pilot holes provided. This lowers the box tuning from 35 Hz to 25 Hz. When appropriate low-frequency boost-and-cut equalization is applied, such as that provided by the Electro-Voice XEQ-2 active crossover/equalizer, the normal system f_3 of 38 Hz is reduced to 28 Hz. (The XEQ-2's low-frequency equalization section is an underdamped, second-order high-pass filter tuned to 29 Hz with a Q of 2, which provides a 6-dB maximum boost at the tuning frequency and a 12-dB-per-octave rolloff below).

SUBPASSBAND SPEAKER PROTECTION

Below the enclosure tuning frequency, cone excursion increases rapidly. Since acoustic output is also falling rapidly, there is no utility

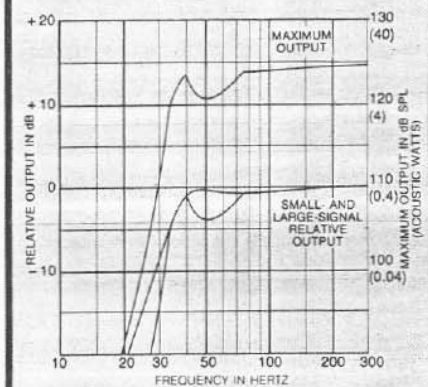


FIGURE 7
TL3512 Computer-Simulated Small- and Large-Signal Total Acoustic Output, Normal Mode

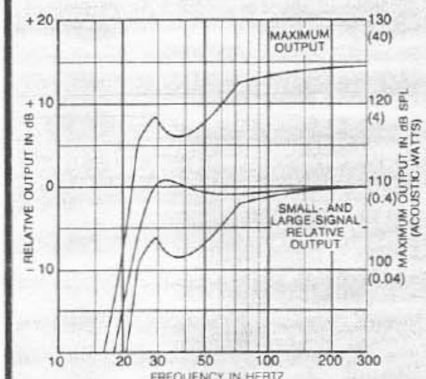


FIGURE 8
TL3512 Computer-Simulated Small- and Large-Signal Total Acoustic Output, Step-Down Mode

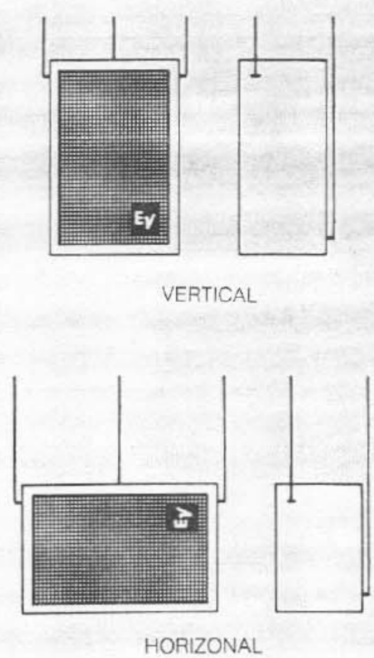
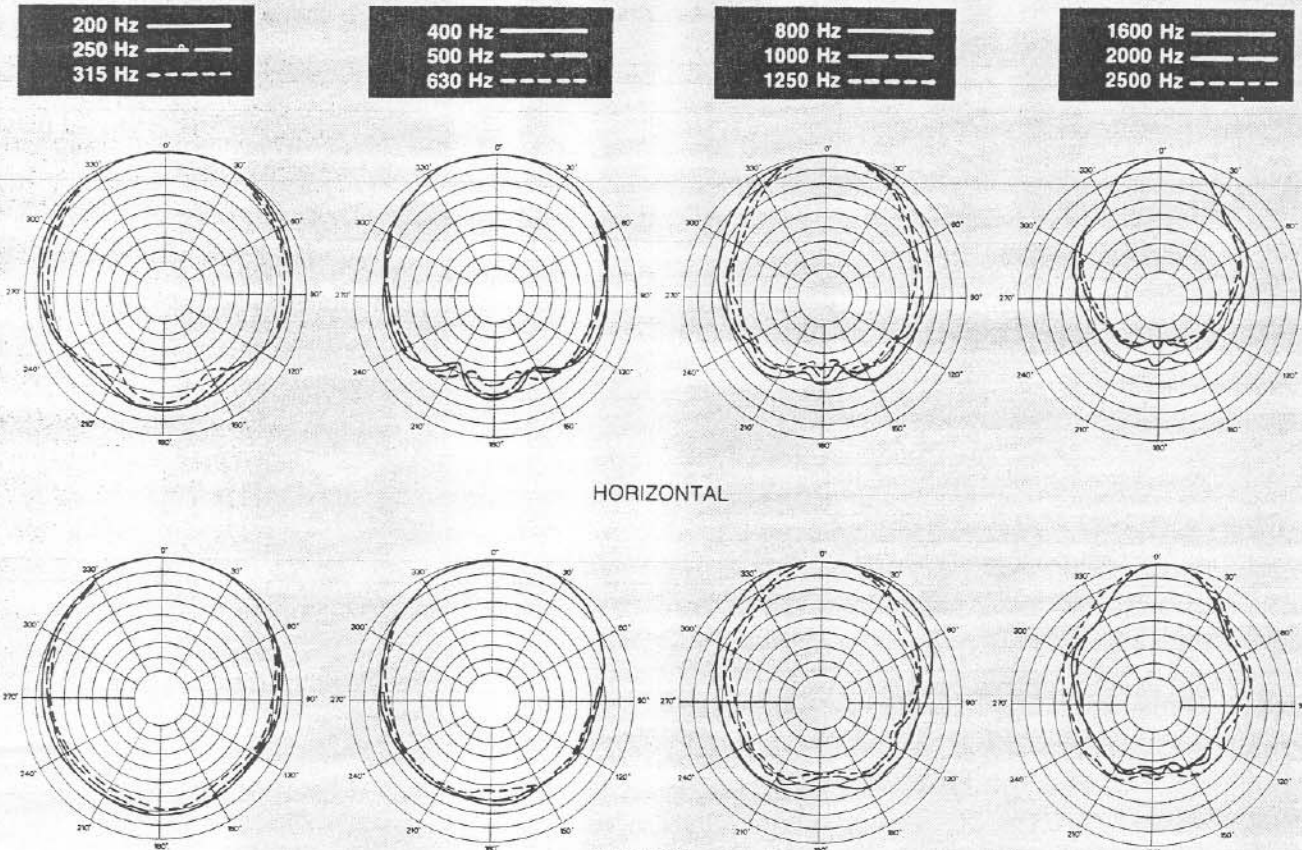


FIGURE 9
Vertical & Horizontal Mounting Methods for the TL3512 using the T-nuts Provided



VERTICAL

FIGURE 2

TL3512 Polar Response (⅓ Octave, 4 Volts/10 Feet)

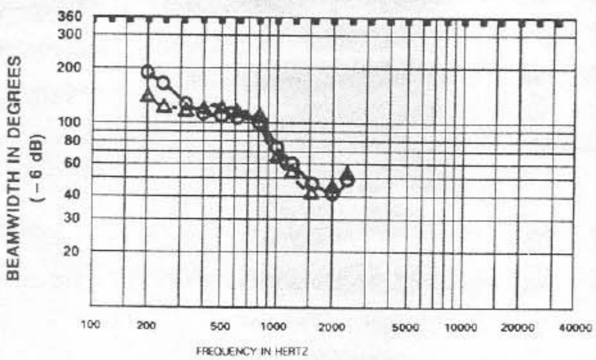


FIGURE 3

TL3512 Beamwidth vs Frequency
Whole Space (Anechoic)

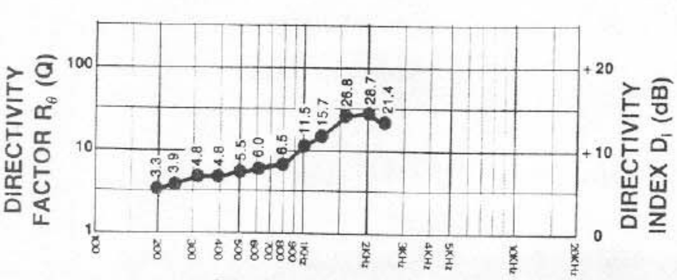


FIGURE 4

TL3512 Directivity vs Frequency
Whole Space (Anechoic)

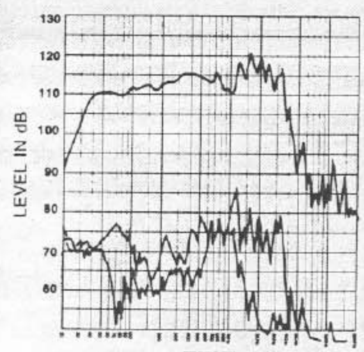


FIGURE 5

TL3512 Harmonic Distortion, 0.1 Rated Power Input (40 Watts), 10 Feet on Axis

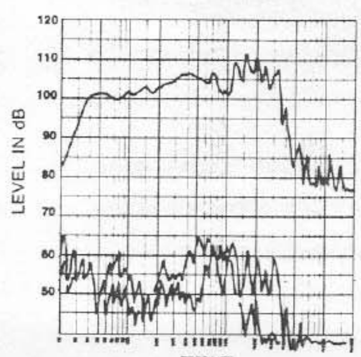


FIGURE 6

TL3512 Harmonic Distortion, 0.01 Rated Power Input (4 Watts), 10 Feet on Axis

in driving the system with signals much below the tuning frequency. While such signals may be in the program material, they are often extraneous—such as from record-surface irregularities (strong 5-25-Hz components) or a dropped microphone. The DL18W very-low-frequency reproducer is ruggedly designed and has a high maximum excursion before damage (±0.5 inch). However, high-output subwoofer systems such as the TL3512 should be protected by a high-pass filter with a 3-dB-down corner frequency of about 0.8 the enclosure tuning frequency. Below the corner frequency, a rolloff of 12 dB per octave is usually sufficient.

Without protection, subpassband signals may "bottom" the DL18W. Damage will probably result, especially after repeated occurrences. Even if bottoming does not occur, the subpassband signals waste amplifier power and modulate (distort) the frequencies which are within the TL3512's operating range. Much "woofer distortion" or "muddy bass" can be attributed to lack of subpassband protection.

The step-down equalization previously described provides protection automatically. The Electro-Voice XEQ-2 active crossover/equalizer also provides protection in its "flat" low-frequency switch position; response is 3 dB down at 30 Hz and falls at 12 dB per octave below that frequency. Other high-pass filters are commercially available. Such protection is also provided by some ⅓-octave equalizers.

SMALL- AND LARGE-SIGNAL PERFORMANCE

The Thiele model allows computer simulation of the TL3512's total acoustic output versus frequency in the piston range of speaker operation (below about 300 Hz). Such information can be developed for both "small-signal" and "large-signal" operating conditions. Small-signal operation is when input power is low, so that system performance is limited by neither the speaker's long-term average power capacity (related to thermal, or heat, destruction) nor its maximum linear cone-excursion ability (as expressed in the Thiele-Small parameter, X_{max}). Such small-signal performance can be loosely thought of as the system's "frequency response." Large-signal performance shows maximum system output, as limited by either the long-term average power capacity or the maximum linear cone-excursion ability, whichever is lowest. While the large-signal limitations of speaker systems have been little publicized, all systems are subject to them. The proper understanding of these limitations can be very important in the successful design of very-high-output, very-low-frequency systems.

Figure 7 shows small- and large-signal performance of the TL3512 in the normal mode. Figure 8 is for step-down operation. The small-signal curves are relative to a 0-dB reference equivalent to the TL3512's half-space efficiency (2.9%). The large-signal relative output curves are shown for easy comparison to the small-signal information; their 0-dB reference is the TL3512's maximum midband acoustic output (2.9% × 400 input watts = 11.6 acoustic watts out). The maximum-output curves show maximum output in absolute terms, when the TL3512 is placed in an acoustic half space (see System Positioning section). Maximum output is shown both in acoustic watts and in dB SPL in the reverberant field (several feet from the speaker and beyond) of a space whose room constant, R, is 200 ft². (This room constant describes a room with a volume of about 3,000 cubic feet and average absorption.) The sound pressure levels associated with other room constants may be calculated as follows:

$$SPL_{new} = SPL_{curve} - 10 \log_{10} \frac{R_{new}}{200}$$

where SPL is the sound pressure level in dB and R is the room constant in ft².

Note: the maximum-output performance shown in Figures 7 and 8 may be increased by using multiple TL3512's. (Small-signal performance is essentially unchanged.) See Use in Multiples section.

USE IN MULTIPLES

TL3512's may be used in multiples to increase acoustic output. In the following discussion, it is assumed that all speaker cones are operating in unison (in phase) when a common signal is applied. A 6-dB increase in maximum acoustic output results when two speakers are located side by side. For operation at very low frequencies, the woofer cones "mutually couple," acting as one speaker with cone area and power-handling capacity twice that of a single speaker. The doubling of cone area doubles efficiency, providing a 3-dB increase in sound pressure level. The second 3-dB comes from the doubling of power capacity.

Mutual coupling occurs when the frequency is such that the center-to-center distance between the two speaker cones is less than about one-quarter wavelength. For a given center-to-center distance, the highest frequency at which mutual coupling will occur can be calculated from the following formula:

$$f \cong \frac{3{,}000}{D_{max}}$$

where D_{max} is the distance in inches and f is frequency in Hz. When D_{max} is greater than one-quarter wavelength, as would occur if two TL3512's were widely spaced, the level increase tends to be limited to the 3-dB power-handling increase.

More than two TL3512's can be used for increased output. In general, maximum acoustic power output ability increases as the square of the number of mutually coupled cones. For example, four cones would provide 4^2 or 16 times the power output of a single cone, an increase of 12 dB ($10 \log_{10} 16 = 12$ dB). Note that the associated increased efficiency (2.9% × 4 = 12%) approaches that of a fully horn-loaded design, but in a much smaller enclosure.

SYSTEM POSITIONING

Subwoofer systems such as the TL3512 are often located on the floor. This is both convenient and can provide a desired high acoustic impact when the speakers are, for example, placed near the periphery of a dance floor. In other installations, such as a theater or auditorium, the audible location of a subwoofer operating at a sufficiently low crossover frequency (below about 125 Hz) will not be particularly evident. The other system elements operating above the subwoofer range can be positioned for the desired locational cues and uniform audience coverage.

Floor location provides the acoustic half-space environment associated with the 2.9% system efficiency noted in the Specifications section. Location at a floor-wall junction (acoustic quarter space) doubles efficiency (a 3 dB increase in sound pressure level) and tends to promote the full exitation of more room modes, or standing waves, important in achieving maximum overall bass output in the room. Corner placement (acoustic eighth space) doubles efficiency again and guarantees exitation of all room modes. (Such placement for maximum efficiency and room-mode exitation is not necessary and may not be desirable or possible for a variety of reasons, including esthetics and building design.)

The TL3512 can also be successfully operated away from any nearby acoustic boundaries, particularly when multiple systems are used for increased output ability (see Use in Multiples section).

MOUNTING

The supplied T-nuts and ¼-20 bolts permit three-point suspension of the TL3512 in either a vertical or horizontal orientation. The location of the T-nuts and the recommended mounting method is shown in Figure 9. For safety reasons, the suspension points must primarily place shear forces on the enclosure panels (no direct outward pull on any surface). The suspensions shown in Figure 9 meet this requirement.

WARRANTY (Limited)

Electro-Voice Professional Sound Reinforcement Loudspeakers and Accessories are guaranteed for five years from date of original purchase against malfunction due to defects in workmanship and materials. If such malfunction occurs, unit will be repaired or replaced (at our option) without charge for materials or labor if delivered prepaid to the proper Electro-Voice service facility. Unit will be returned prepaid. Warranty does not cover finish or appearance items or malfunction due to abuse or operation at other than specified conditions. Repair by other than Electro-Voice or its authorized service agencies will void this guarantee.

For shipping address and instructions on return of Electro-Voice products for repair and locations of authorized service agencies, please write: Service Department, Electro-Voice, Inc., 600 Cecil Street, Buchanan, Michigan 49107 (Phone: 616/695-6831) or Electro-Voice West, 8234 Doe Avenue, Visalia, California 93277 (Phone: 209/651-7777).

Electro-Voice also maintains complete facilities for non-warranty service.

Service and repair address for this product: Electro-Voice, Inc., 600 Cecil Street, Buchanan, Michigan 49107

Specifications subject to change without notice.

ELECTRO-VOICE, INC., 600 Cecil Street, Buchanan, Michigan 49107
MANUFACTURING PLANTS AT ■ BUCHANAN, MI ■ NEWPORT, TN ■ SEVIERVILLE, TN ■ REDMOND, WA ■ GANANOQUE, ONT

a gulton company
Part Number 530505—503